Appendix G
Quality Assurance/Quality Control Procedures

G.1 Contractor Quality Control (CQC) Three-Phase Control Process

G.1.1 Scope and application. The contractor is required to ensure that a quality control program is in place that assures that sampling and analytical activities and the resulting chemical parameter measurement data comply with the data quality objectives (DQOs) and the requirements of the Sampling and Analysis Plan (SAP). This quality control program must be maintained throughout all field and laboratory work by means of a three-phase control process (Engineer Regulation (ER) 1180-1-6, Engineer Pamphlet (EP) 715-1-2. Corps of Engineers Guide Specification (CEGS) 01450 and 01451). The contractor quality control (CQC) process encompasses review of project activities by a contractor-assigned quality assurance (QA) officer at three distinct phases (preparatory, initial, and follow-up). This QA officer must perform these duties whether or not a Government representative is present. All CQC activities are then summarized within the contractor daily quality control reports as outlined in Instruction F-1 of Appendix F. The frequency of implementation is specified by each definable feature of work. A definable feature of work is a task that is separate and distinct from other tasks and has separate control requirements. For example, the definable features of the sample collection task include, at a minimum, each matrix (air, water, soil, containerized waste, etc.) being sampled. In addition, the quality control process shall ensure that minimum data reporting requirements are achieved and shall be implemented according to project requirements.

G.1.2 Preparatory phase. The CQC representative in conjunction with the contractor's sampling team will conduct the preparatory phase inspection prior to the beginning of any definable feature of the work. It includes a review of all work requirements, a physical examination of all required materials and equipment, an examination of work areas to ascertain completion of all preliminary work, and a demonstration of all field activities. If new sampling or technical personnel arrive onsite during the work effort, the CQC representative must repeat the preparatory phase with these personnel prior to their beginning work. All contractor personnel shall have reviewed in detail the SAP, including the Field Sampling Plan and the Quality Assurance Project Plan, prior to this inspection, and will participate in a discussion of all pertinent sections of these plans and/or specifications during the preparatory meeting.

G.1.2.1 Checklist of field equipment and other materials. The following represents a generic checklist of required onsite materials, which should be verified during a preparatory phase inspection. Also presented is a cross-reference to appropriate instructions or appendices within this engineer manual that can support a more detailed inspection. This checklist should be modified as appropriate to accommodate site conditions and be included within the SAP.

G.1.2.1.1 Project plans, and contractual documentation should be present onsite. Verify, as appropriate, that the following are the most recent/approved versions (Chapters 2 and 3):

- Contract plans and specifications
- Project plans: Work Plan, SAP, Site Safety and Health Plan, Standard Operating Procedures (SOPs)
- Summary of QA Elements and associated Measurement Quality Objectives
- Area maps for site identification and documenting sampling locations

G.1.2.1.2 Project logbooks, forms, logs, and tables should be available for documenting tasks as needed (Instruction F-1). The following are examples:

- Field logbooks/indelible ink pens
- Soil boring logs
- Monitoring well installation logs
- Drum logs
- Sample summary tables, corresponding field samples to field control samples (i.e., Tables G-1, 3-3)
- Field instrument calibration tables (Table 3-4)
- Tables for recording of any field data generated
- CQC reports
- Shipping container checklist (i.e., Figure 3-2)
- Chain-of-custody forms (i.e., Figure F-2)
- Laboratory notification checklist (i.e., Figure 3-4)
- Hazardous waste manifest forms
- Sample shipping documents (e.g., air bills)
- Communication and phone logs
- Copy of ENG Form 4025, which remedial action contractors will use to transmit analytical data

G.1.2.1.3 Reference materials should be available in hard copy or by electronic means as needed.

- Technical reference books for the identification of chemical hazards
- Material safety data sheets
- Field instrument manuals
- Reference materials and regulations for proper completion of manifests

Table G-1
Example sample table

Sample Location	Sample Depth	Sample Number (Primary Lab)	QC Sample Number (Primary Lab)	Associated Trip Blank Number (Primary Lab)	Associated Rinsate Blank (Primary Lab)	Sample Number (QA Lab)	Associated Trip Blank Number (QA Lab)	Associated Rinsate Blank (QA Lab)	EPA 8260	EPA 8270	EPA 6010	EPA 8015

Note: This table is to be completed in the file based upon the actual samples taken.

G.1.2.1.4 Field instrumentation and support equipment should be available onsite as needed (Appendix H).

- Field screening instruments
- Calibration gas or standards
- Instrument operating manual and method SOPs
- Reagents and consumables
- Computer software / data station used for data reduction or interpretation
- Established procedures or contracts for instrument repair
- Contingency arrangements or backup instrumentation and equipment, and consumables for field analysis

G.1.2.1.5 Sample collection and handling equipment needed.

- SOPs available for each sampling and sample handling protocol planned (Chapter 4)
- The following sample collection equipment (Appendices C and D): direct (sampling equipment that comes in direct contact with the sample), indirect (augers, drill rods/probes—does not come in direct contact with the sample), and support equipment (drill rig, gas cylinders, generators, etc.)
- Sample handling equipment to support the following tasks: filtration (Instruction E-1), homogenizing/compositing (Instructions E-2, E-3), and PSR, PSS (Instructions E-2)
- Personal protection equipment, gloves, duct tape, etc.
- Sample containers of the types to be used for each test or chemical analysis planned for all environmental samples and any field control (quality control (QC)) samples (Appendix B)
- Labels for sample containers (Instruction F-1)
- Sample preservatives, such as acid for metals, sodium hydroxide for cyanide, methanol or sodium bisulfate for soil volatile organic analysis (VOAs), etc. (Appendix B)
- pH test strips or meter to confirm adequacy of preservation techniques (Instructions C-1, C-2, C-3)

G.1.2.1.6 Decontamination procedures should be established with the following (Instruction E-6):

- SOPs available for each protocol employed for decontamination
- Decontamination reagents and materials including soap, solvents, rinse waters, pails, brushes, paper towels, aluminum foil, etc.

- Supplies for confirmation sampling (e.g., rinsates, wipe samples)
- Containers for storage of investigation-derived wastes, if necessary

G.1.2.1.7 Sample packaging and shipment materials should be available as noted (Instruction F-2).

- Shipping container checklist (i.e., Figure 3-2)
- Sample shipping coolers
- Chain-of-custody forms (others: analysis request forms, laboratory notification checklist, cooler receipt forms (Figure 3-3), etc.)
- Instructions for laboratory on requirements for sample subsampling procedures (Instruction E-5)
- Sample packing materials, including plastic bags, peanuts, paint cans, and/or vermiculite
- Ice packs to cool sample cooler
- Temperature blanks (Instruction G-2)
- Strapping tape
- Chain-of-custody seals
- Address labels, air bill, or shipping papers, including a completed example of the sample shipping documents used
- Laboratory information: name, address, phone number, point of contact, turnaround time for the analyses
- Communication log between field and laboratory personnel. Documentation that all laboratories have been notified that the samples will be shipped and confirmation that the laboratory will accept the samples

G.1.2.2 Checklist of demonstrated activities. The contractor will also be required to demonstrate anticipated sampling procedures during the preparatory phase inspection. The following is a generic checklist of examples that may require demonstration. This listing should be modified to reflect actual conditions anticipated at the site.

G.1.2.2.1 The CQC representative shall review all pertinent sections of the plans and specifications during the preparatory meeting in order to ensure that all field personnel are cognizant of the overall project DQOs as well as any specific sampling and analysis requirements. Likewise the sampling and analysis plan should be reviewed in detail.

G.1.2.2.2 All instruments should be calibrated during the preparatory inspection meeting using certified calibration standards, gases, etc. Personnel may provide dry run of field testing on laboratory control samples, or single-blind performance evaluation (PE) samples. Frequency and contents of data reporting requirements should be discussed.

G.1.2.2.3 The sampling team should demonstrate in detail how each type of sample will be collected, using the intended sample containers, sampling equipment, decontamination, and sample handling procedures.

G.1.2.2.4 Equipment decontamination procedures will be demonstrated in detail using the proper decontamination solutions in accordance with the SAP. If a particular area is to be designated for decontamination, this should be available and established.

G.1.2.2.5 The sample numbering system, sample labeling, and sample shipment documentation requirements should be fully discussed. Recommend a full set of sample custody forms be completed to be used as a guide during sampling activities. The laboratory addresses and phone numbers should be available and recorded on the forms. Analytical test methods and sample preservation requirements will be fully discussed and recorded on the form.

G.1.2.2.6 Laboratory turnaround times shall be established and documented in the minutes of the preparatory meeting. The CQC representative shall present a tracking system to assure that all data are received in a timely manner.

G.1.3 Initial phase checklist of activities. The initial phase inspection shall be performed when sampling is first initiated for each definable feature of work. The contractor's CQC shall oversee sampling activities and review the work for compliance with contract requirements. As a minimum, this shall include the following:

G.1.3.1 The CQC representative should oversee the sampling activities and evaluate the performance for compliance with contract requirements.

G.1.3.2 Initial instrument calibration and ongoing calibrations will be observed, verified, and documented.

G.1.3.3 Field notes will be inspected to assure that all pertinent data are recorded in accordance with the contract requirements. These notes shall include the following items as a minimum:

- Date/time of sampling
- Sampler's signature
- All field screening data (calibration, sample, QC)
- Brief description of sample(s) appearance
- Sample number(s)
- Sampling location(s), including detailed sketch
- Number and type of sampling containers prepared at each location and corresponding analytical method(s) to be used
- Identification of all split samples, blind duplicate samples, rinsate samples, etc.

G.1.3.4 Individual sample labels and chain-of-custody forms will be inspected for accuracy, completeness, and consistency.

G.1.3.5 The packaging and shipping of the samples will also be inspected by the CQC representative.

G.1.3.6 The sampling team leader should complete the table that matches up primary and QA samples at the conclusion of each day of sampling and attach a copy of the contractor's daily quality control reports.

G.1.4 Follow-up phase. The contractor is required to perform follow-up phase inspections on an as-needed basis to ensure continued compliance with contract requirements until completion of that particular feature of work. General procedures and documentation are periodically checked to ensure they are complete, accurate, and consistently executed throughout the duration of the project. Inspections shall also include a review of any field data and the daily calibration log of all instruments being used. It is especially critical that confirmation sampling be closely monitored. Confirmational sample results will serve as the basis for support for DQO attainment or site closure, and the resulting data may be evidence for decisions made by the regulators or customers that the site work has been successfully completed. Therefore, the Government requires absolute assurance that the confirmation samples are properly collected, stored, packaged, shipped, and analyzed.

G.2 Field and Laboratory Control Samples

G.2.1 Scope and application. The scope and application of this instruction is to describe standard control samples that may be included within a project data collection program to support the DQOs. The samples described include field control and/or laboratory QC samples used to assess sources of error at each stage of the sampling and analytical process. The entire sequence of sample gathering, preservation, storage, and shipment has unique errors associated with it, as do the events that occur in the analytical laboratory. To minimize or consider the impact these errors have on the resulting data, a combination of unique field and laboratory QA/QC protocols and control samples are incorporated into the project data collection program based upon project DQOs. U.S. Army Corps of Engineers (USACE) policy on QA/QC implementation is addressed in ER 1110-1-263 and EM 200-1-6.

G.2.2 Field control samples. Principal elements of the sampling and field QA/QC strategy include developing a sound sampling approach based upon the intended use of the data; using sampling methodologies that allow the collection of representative samples based upon data needs; using sampling devices that minimize the disturbance or alteration to the chemical composition of the media; employing decontamination procedures that reduce cross-contamination potential between sampling points; and using proper sample containers and preservation techniques that maximize the integrity of the samples. The applicability and appropriateness of the field sampling protocol can be verified by the inclusion of a program of scheduled field control samples, such as field replicates (duplicates, splits), field blanks (rinsate (equipment), media, bottle, and trip), background (upgradient) samples, and single- or double-blind PE samples. All field control samples shall be handled exactly as the environmental samples. With the exception of matrix spikes/matrix spike duplicates (MS/MSDs), the identity of field control samples collected should be held blind to the laboratory until the data are reported. Further discussion on the unique assignment of sample numbers is contained in Instruction F-1 (Appendix F).

G.2.2.1 Field replicates. Field replicates are samples taken in quantity at a particular location or time in order to assess error associated with sample heterogeneity, sampling methodology applicability, and sample handling techniques. These replicates may be used for various purposes depending upon the intended use of the data or eventual analysis. The different types of replicates include field duplicates/triplicates, field splits, and MS/MSDs. Field QC replicate samples are collocated or homogenized replicates used to assess the field sampling precision. If sufficient field replicate data are available (minimum of eight replicates taken), statistics may then be used to identify the general heterogeneity of the media population being assessed. Similarly, field QA split samples are collocated or homogenized replicates of field samples, except that these are sent to a referee (QA) laboratory for analysis. These field split samples have been used by USACE for early detection of problems with contractor's field sampling, documentation, packaging, and/or shipping errors. Finally, the MS/MSD are collocated or homogenized replicates which are clearly identified as associated with its primary environmental sample. The MS/MSD is used to verify the applicability and effectiveness of the analytical procedures in the project matrix. In addition, this referee laboratory analysis offers a source of data which may provide special attention to the achievement of lower detection limits, allow the performance of supplementary cleanup procedures to avoid matrix interferences, or may help identify an analyte as a laboratory contaminant. These split samples are integral to the USACE Contractor's Quality Assurance Report. It should be noted that the techniques and methodology used for field replicate sample acquisition differ (collocated or homogenized), depending upon the media being sampled and the requirements of subsequent analysis. Refer to Instructions E-2, E-3, and E-4 (Appendix E) for further information on sample handling practices such as homogenization, compositing, and collocated sampling techniques.

G.2.2.1.1 Collocated (grab) replicates. Aqueous media and samples that require grab techniques (e.g., VOA) are field replicates obtained from multiple grab samples, collected separately, and placed directly into sample containers. Theoretically, each grab sample equally represents the medium at a given time and location.

G.2.2.1.2 Homogenized field replicates. Field replicates of solid matrices whose subsequent analysis allows homogenization of the media are obtained from one location in sufficient volume to fill all sample containers. The medium is homogenized and divided into equal quadrants, and equal aliquots from each quadrant are used to fill the sample containers. Refer to Instruction E-2 in Appendix E for details on this sampling technique.

G.2.2.2 Field blanks. Whenever the possibility exists for contributing extraneous material into the sample collection, shipment, or analysis, a blank sample should be used to assess the magnitude of this contribution. Blank samples associated with the field sampling effort include rinsate (equipment), media, bottle, trip, and temperature blanks.

G.2.2.2.1 Rinsate (equipment) blanks. Rinsate blanks are samples of analyte-free (deionized) water that are rinsed over decontaminated sampling equipment, collected, and submitted for analysis. These samples are used to assess cross-contamination from the sampling equipment, in addition to incidental contamination, the sample container, and/or preservatives.

G.2.2.2.2 Media blanks. Media blanks are samples collected following the same sample methodology as the environmental samples without exposure to the contaminant under investigation. Examples include samples of solvent (sodium sulfate or methanol) blanks for solid VOA samples; the filter and solvent media taken in conjunction with wipe samples; filter for vacuum samples; probe blanks for soil gas survey systems, etc. Analysis of these samples allows an evaluation of the contribution due to the media used in sample acquisition.

G.2.2.2.3 Bottle blanks. Bottle blanks are not commonly used on USACE projects; however, they may be required based upon customer or regulatory preference. Bottle blanks are analyte-free (deionized) water for aqueous samples (purified air for canister blanks) that is transferred to a clean sample container in the field and submitted for analysis. A purified solid such as a certified clean sand may also be used. These samples are used to assess the potential incidental contamination due to the field operations (exposure to air) and/or contamination due to the sample container or preservatives, if applicable.

G.2.2.2.4 Trip blanks. Trip blanks are samples of organic-free (deionized) water that are prepared in the laboratory and shipped onsite with the other sample containers. They are then returned to the laboratory unopened in each shipping container that contains aqueous VOA samples and analyzed. Trip blanks are generally prepared with water which meets American Society for Testing and Materials Standard D 1193 requirements and containerized with no headspace. Trip blanks are used to evaluate the potential cross-contamination that may occur during shipment of aqueous samples.

G.2.2.2.5 Temperature blanks. A temperature blank is a container (e.g., 40 mL) of water packaged along with field samples in the shipping cooler that will represent the temperature of the incoming cooler upon receipt at the laboratory. Use of these samples within a shipping container enables the receiving laboratory to assess the temperature of the shipment without disturbing any project field samples.

G.2.2.3 Background (upgradient) samples. Background, upgradient, or upwind samples are samples from a medium similar to that under investigation, but outside the presumed area of contamination. The

sample locations or time should be near that of the field samples but will vary depending upon media and site conditions. These samples are taken to measure the concentration of analytes considered naturally occurring, due to another contaminant source, or due to an interference present within the media itself. Background samples of each unique matrix should be acquired to evaluate the presence of analytes within the field samples. Background samples are especially recommended for complex matrices due to the interferences that may occur during analysis.

G.2.2.4 Single- or double-blind performance evaluation (PE) samples.

G.2.2.4.1 One of the ways of testing a laboratory's/analyst's proficiency in identifying and quantifying analytes of interest is the use of single- or double-blind PE samples. The composition of PE samples is known to the originator, but not the analyst. In a single-blind PE sample, both the originator and the analyst know that the sample is a PE sample. The USACE uses single-blind PE samples as part of the process to validate laboratories. In a double-blind PE sample, the sample is containerized, labeled, and submitted as an environmental sample. The analyst does not know that the sample is a PE sample. Ideally, the PE sample will be indistinguishable from the other project samples. The use of double-blind PE samples is considered a more effective way of detecting problems, since the laboratory would not be aware that it was being evaluated. Currently, commercially available PE samples may be acquired for a complete range of organic and inorganic analytes in both water and soil.

G.2.2.4.2 However, it may be difficult to disguise a standard reference sample as a project sample, and the concentration of the target analytes within the standard reference sample may not be appropriate or useful to the project. For this reason, one may consider the preparation of matrix-specific double-blind PE sample. These PE samples involve the utilization of a sample replicate to which a known quantity of analyte is added and sent blind to the laboratory. It is recommended to spike at levels that pertain to concentrations of concern or action levels associated with that compound or parameter. This type of sample is used to evaluate the laboratory's accuracy by comparing the recovery of analyte reported to the amount added. However, due to the difficulty in achieving thorough and even distribution of the spiked material within the field sample, as well as the potential for field exposure and cross-contamination of other samples due to the presence and handling of the contaminant source in the field, it is not recommended to perform these procedures in the field. Suggest the use of the USACE government laboratory to prepare these types of PE samples from the QA splits received. In addition, the USACE government laboratory can retain a portion of the material to conduct further referee analysis. PE sample data are evaluated for correct compound identification, accurate results quantitation, and assessment of any laboratory contamination. PE samples are recommended for sites that have the potential for a majority of nondetects, for sites where the contaminants of concern have already been identified, or for contracting (laboratory) firms suspected of inaccurately reporting chemical results.

G.2.3 Laboratory QA/QC procedures. Laboratory QA/QC procedures are implemented in order to prevent, detect, and correct errors in the analytical process. In order to ensure that quality data are continuously produced during all analyses, and to allow eventual compliance review, systematic checks are performed to show that test results remain reproducible and that the analytical method is actually measuring the quantity of target analytes in each sample without unacceptable bias. The reliability and credibility of analytical laboratory results are typically corroborated by the inclusion of a program of scheduled analyses of replicates, standards, reference solutions, surrogates, and/or spiked samples. It should be emphasized here that additional volumes and/or samples are required when matrix spike/matrix spike duplicate analysis is required for the project in order to assess the appropriateness and accuracy of the laboratory's analytical method with regard to the matrix under investigation. Refer to Appendix I for details on the scheduled QC procedures required for individual analyses.